MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EMF4076 –ELECTROMAGNETIC INTERFERENCE
(EE, TE& MCE)

1st MARCH 2016
2:30 P.M. – 4:30 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only .
2. Attempt **ALL FOUR** questions .
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Define Electromagnetic Interference (EMI) and explain the THREE (3) aspects that need to exist in order for EMI to take place.

[5 marks]

(b) The equivalent circuit for inductive coupling between three parallel wires is shown in Figure Q1b. A source voltage, V_S, is connected to lead-1. R_{1S} and R_{2S} represent the source resistance for lead-1 and lead-2 respectively, R_{1L} and R_{2L} represent the load resistance for these two leads respectively. The expression for the noise voltage, V_N is shown as below.

$$V_N = \frac{j\omega L_{12} R_{2L} V_S}{(j\omega)^2 (L_1 L_2 - L_{12}^2) + j\omega (L_2 R_1 + L_1 R_2) + R_1 R_2}$$

(i) If V_N can be shown as below,

$$V_N = K \cdot \frac{j\omega V_S}{(j\omega + s_a)(j\omega + s_b)}$$

Obtain the expression for K, s_a, and s_b.

[6 marks]

(ii) Show the frequency response of V_N at low-frequency end, at high-frequency end, and at mid-frequency range.

[3 + 3 + 5 marks]

(iii) Recommend two ways to reduce inductive coupling noise at low-frequency end (refer to equation found in Q1b (ii) for low-frequency end).

[3 marks]

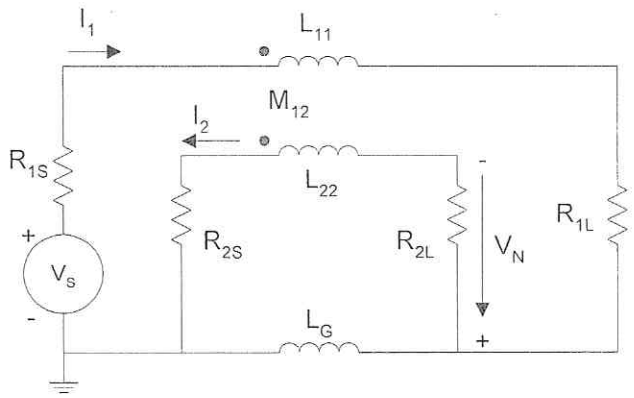

Figure Q1b

Continued . . .

Question 2

(a) EMI problems can be reduced but not totally eliminated by proper design of the printed circuit board (PCB) layout and partitioning.

(i) Name four considerations in partitioning and PCB layout.

[4 marks]

(ii) With the aid of suitable diagrams, explain why ground grid is used to replace ground plane for digital circuits.

[4 marks]

(b) A load with the load current, I_L, is connected to the end of a power distribution bus, and the Thevenin equivalent circuit as shown in Figure Q2b. The decoupling capacitor, C_d is used to prevent load voltage, V_L from decreasing below the minimum acceptable supply voltage, V_s. The length of the bus is 30 cm and the propagation velocity is 40% of the speed of light. Assuming the characteristic impedance, Z_o equals to 50 ohm, and transient current, I_T is a step function that equals to 20 mA.

(i) Find the maximum change in V_L for C_d= 0.01 μF and C_d= 0.

[6 marks]

(ii) What is the required value for C_d in order to limit the change in V_L to 0.02 V?

[2 marks]

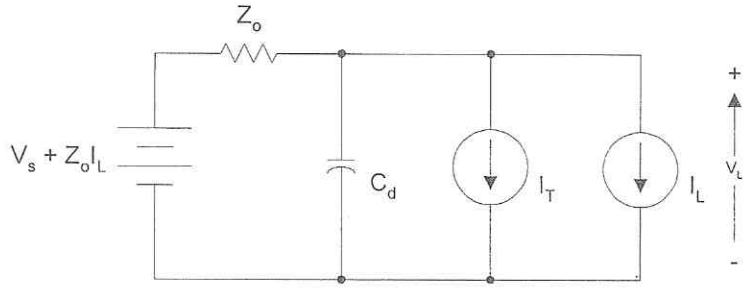

Fig. Q2b

(c) Electrostatic Discharge (ESD) can be a major cause of EMI.

(i) State the FOUR (4) ESD coupling mechanism in electronics circuits.

[4 marks]

(ii) State the precaution that needs to be taken in electronics system to avoid or mitigate ESD occurrences.

[5 marks]

Continued . . .

Question 3

(a) Aluminum (Al) has a higher conductivity than stainless steel (SS). Explain the reason why the shielding effect in term of absorption loss is poorer than stainless steel by comparing their skin depths.
[Hint: Relative permeability (μ_r) for Al and SS are 1 and 300 respectively.]
[7 marks]

(b) A wire carrying a 0.5 mA current at 250 MHz is parallel to a ground plane, at a height of 1 cm. The length of the wire is 2 m. Estimate the electric field strength at a distance r = 10 m above the ground plane (with the antenna oriented parallel to the wire). Calculate the voltage in dBμV that will be detected at the antenna terminals if the antenna factor is 12 dB.

[*Given the far-field expression for E-field due to a small current-loop of loop-area A, carrying a time varying current is $I_o e^{j\omega t}$ is: $|E_S| = 30\frac{k^2 I_o A}{r}$ where k is the propagation constant.]
[9 marks]

(c) Suggest THREE (3) steps that can minimize radiation due to electric dipole.
[6 marks]

(d) Overall shielding effectiveness of a shielding material is determined by THREE (3) main factors. List them.
[3 marks]

Question 4

(a) Explain why it is necessary to set international standards for Electromagnetic Compatibility (EMC).
[2 marks]

(b) Describe the THREE (3) certification routes as per European EMC regulations.
[6 marks]

(c) An antenna is connected to a spectrum analyzer using a 10 meters coaxial cable to measure the radiated emission from an equipment under test (EUT). The distance between the EUT and the antenna is 3 meters. The loss of the coaxial cable is 1.5 dB per meter at 200 MHz and 2.4 dB per meter at 450 MHz. The antenna factor is 4 dB and 8 dB at 200 MHz and 450 MHz, respectively. If the reading on the spectrum analyzer is 25 dBμV for both frequencies,

Continued . . .

(i) Compute the electric field strength at the antenna in dBμV/m for 200 MHz and 450 MHz.

[5 marks]

(ii) The EN55022 radiated emission limits are given in Table Q4c. Evaluate whether the product passes or fails the EN55022 Class B radiated emission test, and by how many dB.

[4 marks]

Table Q4c

Frequency Range (MHz)	Class B limit at 3m (μV/m)	Class B Limit at 10m (μV/m)
30 to 230	106.67	32
230 to 1000	236.43	71

(d) (i) Define site attenuation, and Normalised Site Attenuation (NSA).

[4 marks]

(ii) NSA measurements are performed for both horizontal and vertical polarizations, with the transmit antenna positioned at a height of 1 m (for broadband antennas) and the receive antennas swept over the height scan of 1 m - 4 m for 3 m and 10 m sites. Evaluate the rationale of the height scan.

[4 marks]

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